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Exploring socioeconomic determinants of goat herd size: A case study of smallholder farmers in Lephalale local municipality, Limpopo, South Africa

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CITATION

Seleka TA, Senyolo MP, Mokhaukhau JP. (2024). Exploring socioeconomic determinants of goat herd size: A case study of smallholder farmers in Lephalale local municipality, Limpopo, South Africa. *Journal of Infrastructure, Policy and Development*. 8(13): 8091.
<https://doi.org/10.24294/jipd8091>

ARTICLE INFO

Received: 19 July 2024
Accepted: 4 September 2024
Available online: 8 November 2024

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Abstract: Goat farming plays an important economic role in numerous developing countries, with Africa being a home to a considerable portion of the global goat population. This study examined the socioeconomic determinants affecting goat herd size among smallholder farmers in Lephalale Local Municipality of the Limpopo Province in South Africa. A simple random sampling technique was used to select 61 participants. The socioeconomic characteristics of smallholder goat farmers in Lephalale Local Municipality were identified and described using descriptive statistics on one hand. On the other hand, a Multiple linear regression model was employed to analyse the socioeconomic determinants affecting smallholder goat farmers' herd sizes. Findings from the Multiple linear regression model highlighted several key determinants, including the age of the farmer, gender of the farmer, education level, and marital status of farmers, along with determinants like distance to the markets, provision of feed supplements, and access to veterinary services. Understanding these determinants is crucial for policymakers and practitioners to develop targeted strategies aimed at promoting sustainable goat farming practices and improving the livelihoods of smallholder farmers in the region.

Keywords: herd size; goat farming; smallholder farmers; Lephalale local municipality

1. Introduction

Goat farming is one of the largest agricultural industries in developing nations, and Africa is home to about 35% of the world's goat population (Manirakiza et al., 2020). Since being domesticated by humans 10,000 years ago, goats have played a significant role in humanity and have subsequently expanded worldwide (Mataveia et al., 2021). Their value stems from the fact that they may be milked for domestic use and sale. Other socioeconomic uses for goats include festivals, religious, and ceremonial celebrations. Since goats contribute to food security, they can potentially reduce poverty in Africa (Wodajo et al., 2020). According to Namonje-Kapembwa et al. (2022), goats have benefits over cows because they are more fertile and have a shorter reproductive cycle. They also have a relatively high adaptability to different climatic conditions. In addition, goats also release less methane into the atmosphere than domestic ruminants and can survive in harsh climatic conditions (Pragna et al., 2018).

Lubungu (2017) argued that the structural shifts in developing nations' economic and demographic landscapes opened a wide range of options for smallholder livestock producers to participate in the economic growth from which they have previously been completely excluded. Given the challenges posed by climate change in agriculture, the production of climate-resilient livestock emerges as a critical strategy for ensuring food security and sustainable agricultural livelihoods. Prospects for farmers to

commercialize and profit from the rising demand for animals and livestock products are however, limited by the small livestock herd sizes. The value of livestock is also evident in its role as a form of traditional banking that greatly enhances the quality of life in rural communities by generating income and providing access to high-quality animal protein (Saeed et al., 2022).

As people consume more meat, livestock population and production have a significant potential to drive economic growth. Furthermore, Lubungu (2017) asserted that increasing herd size is essential to the sector's success and ensuring that farmers fully benefit from its growth. Similarly, a larger herd size is a key factor that influences farmers' participation in marketing, which significantly impact the income off-take levels (Mataveia et al., 2021).

The commercialization of livestock is limited by herd size, diseases and climate change (Lubungu, 2017). In South Africa, a large portion of the goat population is maintained in poor conditions. These goats typically have small body frames, low productivity, and poor meat quality since they are hardy, and can adapt to foraging in degraded environments (Chilanga, 2020). In some instances, goats are left to fend for themselves in areas with limited or poorly maintained grazing lands (Dwyer, 2022). As a result, veterinary treatment is typically lacking in smallholder goat husbandry, which leads to high death rates, subclinical diseases, and low reproductive rates (Kichamu et al., 2024). High goat expansion primarily occurs through birth while acquisitions serve as the main source of stock. High mortality rates suggest that deaths are the main way for the herd to exit the stock and the goat subsector indicate that reducing mortality rates positively impacts herd size (Lubungu, 2017).

Visser and van Marle-Köster (2016) suggested that the expansion of livestock, which primarily focuses on enhancing productivity and income, has a significant impact on the commercial sector. However, the benefits for the unorganized rural goat sector have been minimal, largely due to the relatively small number of goats owned by each small-scale farmer and lack of formal markets. Similarly, overcoming the challenge of low market participation necessitates understanding the factors involved in establishing and maintaining herd size such as ensuring a balanced diet, access to grazing pastures, and disease control (Ali et al., 2019; Shahudin et al., 2018).

Studies conducted on smallholder goat production focused on market participation, disease tolerance, and genetics, among others (Nair et al., 2021; Ngwako et al., 2021; Tesema et al., 2020). However, there is a literature gap that remains in assessing the determinants affecting herd size. Therefore, this study explored the socioeconomic determinants influencing the herd size among smallholder goat farmers in Lephale Local Municipality, Limpopo, South Africa.

2. Literature review

The herd size primarily increases the income of farmers which ultimately positions them as food secure. However, programs on herd health which focus on enhancing the performance and productivity of the herd by managing feeding, breeding, parasite control, immunization, biosecurity, and the environment are lacking in rural farming (Shahudin et al., 2018). When goats are exposed to diseases, feeding and breeding will be reduced which ultimately results in low production. Mazhangara

et al. (2019) argued that diseases negatively impact the goats' ability to reproduce, grow, survive, and perform. Moreover, when a disease develops and treatment is necessary, productivity losses could happen if the treatment is inefficient or delayed.

Shahudin et al. (2018) reasoned that the difficulty of providing the animals with a balanced diet throughout the year is one of the main obstacles to expanding goat production. This is brought by the lack of accessible grazing pastures and a hot, humid climate that makes it difficult to grow ruminant-friendly grass (Cannas et al., 2019). In an intensive farming system, goats are more susceptible to illness and have a higher mortality rate. This is because illnesses spread more quickly between animals in an environment with a high stocking density due to air, faeces, and urine.

Otoikhian et al. (2021) posited that goats can continue to produce and reproduce even in tough weather conditions and are resistant to illnesses, heat stress, droughts, a lack of food and water, and other environmental stresses. This is partly due to their smaller size, which allows them to use low-quality fodder effectively, as well as their tolerance for water scarcity and ability to maintain improved thermoregulation (Namonje-Kapembwa et al., 2022). Saeed et al. (2022) highlighted that even though huge herds may considerably increase the risk of disease outbreaks and other issues, socioeconomic elements of humans are increasingly being examined in managing farm resources and, consequently, animal farms.

Given that precipitation affects plant biomass and plant nutrient concentration, a unit increase in precipitation is linked to a decrease in goat ownership. Taruvinga et al. (2022) found that different kinds of livestock are badly impacted by an increase in precipitation. This is because extreme rainfall can lower pasture quality. Additionally, heavy rains can cause waterlogging and floods, which tend to encourage the spread of diseases including rift valley fever, anthrax, and parasite infestation (Ali et al., 2019).

The various diseases that affect goats, most of which result in abortion, delayed oestrous, and decreased fertility, are one of the main factors contributing to changes in herd size (Ali et al., 2019). These illnesses include brucellosis (enzootic abortion) and campylobacteriosis. Similarly, infectious diseases, particularly those that affect reproduction, hinder the economic potential of goats (Taruvinga et al., 2022). However, proper management and favourable climatic conditions can improve the health of these livestock.

A decline in reproductive performance may result from limited food resources (Ali et al., 2019). High feed consumption can also boost reproductive output while both short-term and long-term undernutrition may have a harmful impact on goats' ovarian activity. To extend the seasonal breeding period, the feed flushing mechanism has been proposed in goat management system. In cyclic goats, a short-term high-protein and energy diet causes an increase in blood glucose and insulin concentration. Similarly, high feed consumption has an impact on the follicular environment, namely the glucose level of the follicular fluid (Cannas et al., 2019). Given this information, it is evident that an increase in herd size is caused by proper farm management, proper feed, diseases and favourable climate change.

3. Material and methods

3.1. Study area

The study was conducted at the Lephhalale Local Municipality which is in the Waterberg District Municipality of the Limpopo Province, South Africa. According to the Waterberg District Profile (2020), the Lephhalale Local Municipality is situated in the district's north-western region. Lephhalale Local Municipality is one of the country's coal mining hubs and is known as an energy powerhouse. The population of Lephhalale is 140,240 people, making up to a total household of 43,002 (Lephhalale Local Municipality IDP, 2020/2021). Ga-Seleka village in the Lephhalale Local Municipality, was chosen as a data collection point given the diverse population and agricultural activities within this rural area.

Lephhalale's climate zones changes from south to north, becoming both warmer and drier. The average daily temperature varies between 4 °C and 20 °C in the winter and between 17 °C and 32 °C in the summer. The long-term average annual rainfall is roughly 400–600 mm (Lephhalale Local Municipality IDP, 2020/2021). Therefore, this climatic condition is suitable for goat production. Lephhalale smallholder agriculture is dominated by goat production than any other livestock and that is because, goats are easy to manage; their by-products make life easier for Lephhalale residents and many households rely on their excretion to compose fertilizers for crops, which reduces dependence on fertilizers.

3.2. Data collection and sampling procedures

Primary data was collected through a semi-structured questionnaire, which was administered in the form of contact interviews with smallholder goat farmers in the study area. Due to the unknown total population of smallholder goat farmers and their exact location in the study area, purposive and snowball sampling were employed. Ga-Seleka village in the Lephhalale Local Municipality was purposively selected, based on the active goat production. Snowball sampling was used to identify the respondents, smallholder goat farmers. Ga-Seleka was also chosen since it is the largest village in the municipality, and the targeted sample size was acquired in this village. Given the population 21,868 people in the of Ga-Seleka, the Yamane formula for calculating the sample size was used. The margin of error used was 12.60. At the confidence level of 95%, the population proportion was set at 50%. Therefore, the sample size was calculated as 61.

3.3. Analytical techniques

Descriptive statistics was used to identify and describe the socioeconomic characteristics of smallholder goat farmers in the study area. According to Mishra et al. (2019), descriptive statistics is one of the branches of statistics that are used to describe the population data, by employing the measures of location (both central and non-central), which include amongst others, mean, median, mode, quartiles, deciles, and percentiles.

A Multiple linear regression analysis was used to analyse the socioeconomic determinants of herd size among smallholder goat farmers in the Lephhalale Local Municipality. Tranmer et al. (2020) argued that Multiple linear regression is known to be the extension of the Simple linear regression to incorporate many explanatory variables. Moreover, the explanatory variables are referred to as being linearly

combined because it is believed that the relationship between the response variable and these factors is linear. The general equation for Multiple linear regression is expressed as:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \mu_i$$

where Y is the dependent variable (herd size), β_0 is the constant, $\beta_1 \dots \beta_n$ are the coefficients of the parameters, $X_1 \dots X_n$ are the parameters, and μ_i is the error term.

3.4. Model specification

HDS = $\beta_0 + \beta_1$ AGE (age) + β_2 GND (gender) + β_3 LED (level of education) + β_4 MRST (marital status) + β_5 HSZ (household size) + β_6 HINC (total household Income) + β_7 EMP (employment status) + β_8 ACC (access to credit) + β_9 ACM (access to output market) + β_{10} DMK (distance to input market) + β_{11} YEXP (years of experience in farming) + β_{12} NGRZ (natural grazing) + β_{13} VTS (access to veterinary services) + β_{14} AGTR (agricultural training) + β_{15} RFRM (reason for farming) + μ_i .

4. Results and discussion

The results presented in **Table 1** show the comprehensive outcome of the socioeconomic characteristics and farming-related variables among smallholder goat farmers in Lephalale Local Municipality, Limpopo Province, South Africa, with a sample size of $N = 61$. From the results, the oldest and youngest farmers were 85 and 26 years old, respectively, with an average age of 59 years. These results suggest that most farmers in the study area were elderly. In terms of education level, the highest number of years spent schooling is 17. On average, respondents in the study area are likely to spent 5 years in an educational setting. The higher the level of education possessed by the population within a village, the higher the probability of development of the concerned village (Manlosa et al., 2019).

Table 1. Socioeconomic results ($N = 61$).

| Variables | Range | Min. | Max. | Mean | Std. deviation | Variance |
|----------------------------------|-------|------|------|-------|----------------|----------|
| Age | 59 | 26 | 85 | 58.93 | 16.309 | 256.996 |
| Level of education | 17 | 0 | 17 | 9.25 | 4.755 | 22.614 |
| Household size | 13 | 2 | 15 | 5.67 | 2.688 | 7.224 |
| Distance to nearest input market | 10 | 40 | 50 | 44.59 | 5.025 | 25.246 |
| Years of experience in farming | 34 | 2 | 36 | 13.64 | 11.879 | 141.101 |
| Herd size | 26 | 5 | 31 | 13.72 | 6.778 | 45.938 |

Source: Author’s survey (2023).

The mean household size was 5.67, which is approximately 6 individuals per household as presented in **Table 1**. The smallest household had 2 individuals whereas the largest one had 15. The distance to the nearest market for farming activities ranged from 40 to 50 km, with a mean distance of 44.59 km and a standard deviation of 5.025. This indicates that, on average, participants had to travel a considerable distance to

access markets, which could potentially impact their farming practices and productivity. Participants' experience in goat farming ranged from 2 to 36 years, with a mean of 13.64 years (roughly 14 years) and a standard deviation of 11.879, suggesting a wide range of experience levels among the respondents. The considerable standard deviation indicates substantial variability in farming experience within the sample, which could influence farming decisions and practices. The mean average of goats kept is 26, with 5 and 31 being the minimum and maximum, respectively. This implies that the number of years in farming and herd size are directly proportional, the more experienced farmers have in goat production, the more they acquire information that affects their output positively leading to a greater number of goats kept.

Table 2. Socioeconomic characteristics of the farmers.

| Variables | Responses | Frequency | Percentage (%) |
|-------------------------------|--------------------------------|-----------|----------------|
| Gender | Male | 33 | 54.1 |
| | Female | 28 | 45.9 |
| Marital status | Married | 31 | 50.8 |
| | Single | 20 | 32.8 |
| | Widowed | 8 | 13.1 |
| | Divorced | 2 | 3.3 |
| Total Household Income | Less than R1000 | 0 | 0 |
| | Between R1000 and R5000 | 40 | 65.6 |
| | Between R5000 and R10000 | 15 | 24.6 |
| | More than R10000 | 6 | 9.8 |
| Employment | Employed | 16 | 26.2 |
| | Unemployed | 45 | 73.8 |
| Access to output market | Yes | 0 | 0 |
| | No | 61 | 100 |
| Access to credit | Yes | 0 | 0 |
| | No | 61 | 100 |
| Natural grazing | Yes | 61 | 100 |
| | No | 0 | 0 |
| Access to veterinary services | Yes | 5 | 8.2 |
| | No | 56 | 91.8 |
| Agricultural training | Did receive. | 0 | 0 |
| | Did not receive. | 61 | 100 |
| Reason for farming | Consumption | 4 | 6.6 |
| | Marketing | 2 | 3.3 |
| | Both consumption and marketing | 48 | 78.7 |
| | Other | 7 | 11.5 |

Source: Author's survey (2023).

Table 2 shows the percentages of farmers' socioeconomic characteristics. From

the number of goat farmers who responded, 33 and 28 were males and females, respectively. Similarly, the study by Offor et al. (2018) reported that more men were involved in small ruminant farming than women. From the sample size, 51% of the respondents were married and 49% were not married. Concerning household income, none of the farmers reported having a total household income of less than R1000. About 65.6% had an income ranging between R1000 and R5000, 24.6% had between R5000 and R10000, and 9.8% had an income of more than R10 000. This suggests that as farmers' income increases, they can cover their expenses and the option of buying more goats to increase their herd. Venkatachalapathy and Saifudeen (2020) reported that more farmers who have average household incomes, limited their farm spending resources.

Regarding the employment status of the smallholder goat farmers within the study area, those who were unemployed accounted for 73.8%, and only 26.2% of the respondents were employed as shown in **Table 2**. Concerning credit accessibility, access to the output market, and agricultural training, none of the farmers participated in these activities in the past 12 months. According to Hostiou et al. (2020), unemployment can worsen the farmers' financial stability, making it difficult to invest in goat farming businesses. Lack of access to credit can limit the farmers' ability to buy essential resources like better breeds, veterinary care, or high-quality feed, and that can negatively impact their productivity and possible profits. Limited access to the output market can restrict the expansion of smallholder goat farming. Farmers may find it difficult to attract customers or sell their goats at affordable prices in the absence of reliable and easily accessible markets, which could result in decreased profits and discourage farmers from growing their businesses (Ngwako et al., 2021). Additionally, no farmer reported that their goats do not graze naturally. About 91.8% of the farmers do not have access to veterinary services, and only 8.2% are reported to have access to veterinary services. As for reasons for farming, 3.3% was for marketing, 6.6% was for consumption, 78.7% was for both consumption and marketing and lastly, 11.5 % was for other reasons while 4.9% was for ancestral calling, and 6.6% was for passion of farming.

Multiple linear regression results

The model summary in **Table 3** provides crucial insights into the relationship between various socioeconomic determinants and goat herd size among smallholder farmers in Lephalale Local Municipality, Limpopo Province, South Africa. The adjusted R square (0.608) of the Multiple linear regression analysis, suggests that the included predictor variables collectively explain a significant proportion of the variance in goat herd size. This value implies that 60.8% of the variability in goat herd size can be accounted for by the socioeconomic determinants examined in the model.

The Multiple linear regression results presented in **Table 3** further shows that the age of the farmer had a positive relationship with the dependent variable (herd size). The results imply that a 1-year increase in the age of the farmer will increase the goat herd size by 0.252 units. This suggests that with increasing age, farmers will accumulate larger herds, possibly due to accumulated experience and resources over time (Saeed et al., 2022).

Table 3. Multiple linear regression results.

| Variables | B | Std. Error | T-ratio | Sig |
|--------------------------------|----------|---------------------------------|----------------|------------|
| Constant | -29.174 | 9.086 | 3.211 | 0.002 |
| Age | 0.082 | 0.071 | 1.159 | 0.252 |
| Gender | 4.654 | 1.496 | 3.110 | 0.003*** |
| Level of education | 0.368 | 0.154 | 2.395 | 0.021** |
| Marital status | -1.660 | 1.584 | -1.048 | 0.300* |
| Household size | 0.221 | 0.241 | 0.915 | 0.365 |
| Total Household income | 2.979 | 1.017 | 2.930 | 0.005*** |
| Employment status | -5.051 | 1.700 | -2.971 | 0.005*** |
| Distance to the nearest market | 0.360 | 0.140 | 2.579 | 0.013** |
| Years of experience in farming | 0.236 | 0.075 | 3.138 | 0.003*** |
| Access to veterinary services | 2.717 | 2.399 | 1.133 | 0.263 |
| Reason for farming | 2.151 | 0.996 | 2.160 | 0.036** |
| <i>R</i> Square: 0.68 | | Adjusted <i>R</i> square: 0.608 | | |

Note: ***, **, * represents significance at 1% ,5% and 10% respectively.

Source: Author’s survey (2023).

The variable gender of the respondents was found to be positively significant at a 1% level of significance. This shows that men dominated goat farming in the study area, and it could be attributed to various factors such as access to land, available resources, or traditional norms influencing livestock management. These results are in line with Offor et al. (2018), who found gender to be correlated with the output of small ruminant animal production. However, Venkatachalapathy and Saifudeen (2020) found that gender does not affect the total number of goats reared. This could be that men are usually responsible for the management of livestock in the household.

The respondents’ education level was revealed to be positive and significant at 5%. This suggests that as the level of education increases, so does the goat herd size. This is congruent with the findings of Nwachukwu and Berekwu (2020), who discovered a strong and positive relationship between educational level and goat production output. Education can help smallholder farmers learn knowledge and skills in a range of areas, such as animal husbandry, nutrition, and disease management which can assist in increasing production.

Marital status was negative and significant at the 10% significance level, indicating that being married does not enhance herd size. In other words, being married predicts having a smaller goat herd size than being unmarried (Tsvuura et al., 2021). This suggests that when one is not married, they have the power to take risks in financial decision-making as their responsibilities might not be the same as married farmers. This discovery contradicts the notion that marriage would increase herd sizes given that larger herd sizes will increase household income and improve food security.

The negative and significant coefficient for employment status at the 1% significance level suggests that an increase in farmers’ employment status is associated with a decrease in herd size among smallholder farmers in the study area. Farmers who are more employed, or potentially have higher levels of employment engagement, tend to have smaller herds compared to those with lower levels, holding other factors

constant. This finding aligns with the notion that farmers who work in secure, well-paying jobs may indeed have more disposable income available for investment in their goat farming businesses, however, they might lack the necessary time and effort to dedicate to herd expansion and management. On the other hand, self-employed farmers with more flexible schedules may have the opportunity to allocate more time and effort to their goat farming activities, potentially leading to larger herd sizes despite having less disposable income. These results corroborate with the findings of Taruvinga et al. (2022).

Distance to the market was shown to be positively significant at 5%. The findings are consistent with those of Namonje-Kapembwa et al. (2020), who found that distance to market impacts goat herd size and marketing. Smallholder goat farmers living near input markets such as feed sellers, veterinary clinics, and animal health products may have better access to these services at lower transportation costs. However, some farmers may still be forced to pay for transportation due to limited road infrastructure or other logistical issues. Nevertheless, residing close to the input marketplace can make it easier for farmers to sell their goats to output markets. This may have favourable effect on their herd size because farmers living near the marketplaces may have more opportunities to sell their goats for a profit (Ngwako et al., 2021).

Years of farming experience were found to be significant at a 1% level. This suggests that the more experience farmers have in goat production, the larger their herd size. The findings are consistent with those of Nwachuku and Berekwu (2020), who found that experienced smallholder goat farmers tend to have larger herds than those who are just starting.

The findings regarding the variable of provision of feed supplements indicate that, when controlling for other factors, increasing the provision of feed supplements for goats is associated with a corresponding increase in the herd size. The results suggest that providing adequate and suitable feed supplements can help increase goat health, development, and reproductive rates, increasing the total herd size. Kulkarni et al. (2014) attested that farmers who focus and invest in supplying quality feed supplements to their goats may have better success raising herd levels than those who do not.

Access to veterinary services resulted in a positive relationship with the dependent variable, herd size. The results suggest that the more access the farmer has to veterinary services, the more their goat herd size will increase. This is because access to veterinary services improves animal health, controls and prevents diseases, and provides nutritional and reproduction advice (van Herten and Meijboom, 2019).

5. Conclusion

The study explored the socio-economic determinants of goat herd size among smallholder farmers in Lephalale Local Municipality within the Limpopo Province. The study revealed that herd size is significantly influenced by several determinants, including gender, household income, employment status, distance to the input market, and reason for farming. Year of experience in goat farming also emerged as a significant factor implying that farmers with more experience tend to have larger herd

sizes. These determinants outline the importance of developing strategies that foster the promotion of sustainable agriculture. Given the adaptability of goats to various climatic conditions, the study recommends that marketing channels be developed in local areas to promote the production of goats. Range management, feeding methods, herd health management, production efficiency, and the use of unconventional foods should all be addressed through government extension programs and other farmer development programs. Since the focus of this study was on herd size and its determinants, there is a need for research into the constraints of market participation and the willingness of smallholder goat farmers to commercialize in Lephalale Local Municipality. In addition, an extension of the study to the broader South Africa can assist in positioning the goat sector in the country given that only few farmers were selected.

Author contributions: Conceptualization, TAS and MPS; methodology, TAS; validation, TAS, MPS and JPM; formal analysis, TAS; investigation, TAS; resources, TAS; data curation, TAS; writing—original draft preparation, TAS; writing—review and editing, TAS, MPS and JPM; visualization, TAS; supervision, MPS; project administration, TAS and MPS. All authors have read and agreed to the published version of the manuscript.

Conflict of interest: The authors declare no conflict of interest.

References

- Ali, S., Zhao, Z., Zhen, G., Kang, J.Z., and Yi, P.Z., 2019. Reproductive problems in small ruminants (Sheep and goats): A substantial economic loss in the world. *Large Animal Review*, 25(6), pp.215–223.
- Cannas, A., Tedeschi, L.O., Atzori, A.S. and Lunesu, M.F., 2019. How can nutrition models increase the production efficiency of sheep and goat operations? *Animal Frontiers*, 9(2), pp.33–44.
- Chilanga, F., 2020. Growth performance, carcass characteristics, meat quality and profitability of local Malawi goats under pen fattening conditions (Doctoral dissertation, International Institute of Tropical Agriculture).
- Dwyer, C.M., 2022. Farming sheep and goats. In *Routledge Handbook of Animal Welfare* (pp. 89–102). Routledge.
- Hostiou, N., Vollet, D., Benoit, M. and Delfosse, C., 2020. Employment and farmers' work in European ruminant livestock farms: A review. *Journal of Rural Studies*, 74, pp.223–234
- Kichamu, N., Astuti, P. K., Wanjala, G., Strausz, P., Bagi, Z., & Kusza, S. (2024). A Review on Indigenous Goats of East Africa: A Case for Conservation and Management. *Biology*, 13(6), 419.
- Kulkarni, P., Veeranna, K. C., Rao, R. B., and Mageppa, H. (2014). Effect of supplementary feeding in osmanabadi goats: a participation action research analysis from India. *International Journal of Agricultural Extension*, 2(3), pp.205–210.
- Lephalale Local Municipality IDP, 2020/2021. Lephalale Local Municipality. Available on: Lephalale Local Municipality IDP, 2020/2021.
- Lubungu, M., 2017. Factors affecting the livestock herd size among smallholder households in Zambia. *Tropical animal health and production*, 49(8), pp.1607–1612.
- Manirakiza, J., Hatungumukama, G., Besbes, B. and Dettleux, J., 2020. Characteristics of smallholders' goat production systems and effect of Boer crossbreeding on body measurements of goats in Burundi. *Pastoralism*, 10, pp.1–11.
- Manlosa, A.O., Schultner, J., Dorresteyn, I. and Fischer, J., 2019. Leverage points for improving gender equality and human well-being in a smallholder farming context. *Sustainability Science*, 14, pp.529–541.
- Mataveia, G.A., Visser, C. and Siteo, A., 2021. Smallholder goat production in Southern Africa: A review. *Goat Science-Environment, Health, and Economy*.
- Mazhangara, I.R., Chivandi, E., Mupangwa, J.F. and Muchenje, V., 2019. The potential of goat meat in the red meat industry. *Sustainability*, 11(13), p.3671.

- Mishra, P., Pandey, C.M., Singh, U., Gupta, A., Sahu, C. and Keshri, A., 2019. Descriptive statistics and normality tests for statistical data. *Annals of cardiac anesthesia*, 22(1), p.67.
- Nair, M.R., Sejian, V., Silpa, M.V., Fonsêca, V.F.C., de Melo Costa, C.C., Devaraj, C., Krishnan, G., Bagath, M., Nameer, P.O. and Bhatta, R., 2021. Goat as the ideal climate-resilient animal model in tropical environment: revisiting advantages over other livestock species. *International Journal of Biometeorology*, 65, pp.2229–2240.
- Namonje-Kapembwa, T., Chiwawa, H. and Sitko, N., 2022. Analysis of goat production and marketing among smallholder farmers Zambia. *Small Ruminant Research*, 208, p.106620.
- Ngwako, G., Mthenge, M., Gido, E. and Kgosikoma, K., 2021. Effect of market participation on household welfare among smallholder goat farmers in Botswana. *Journal of Agribusiness and Rural Development*, 60(2), pp.151–160.
- Nwachukwu, C.U., and Berekwu, N., 2020. Production and management of goat rearing in rural areas of Ezinihitte Mbaise, Imo State, Nigeria. *Agro-Science*, 19(3), pp.25–31.
- Offor, E.I., Ekweanya, N.M., and Oleka, A.C., 2018. Effects of socio-economic factors on small ruminant production in Ohafia Agricultural Zone of Abia State, Nigeria. *Agro-Science*, 17(3), pp.7–11.
- Otoikhian, C.S., Otoikhian, A.M., Akporhwarho, O.P., Oyefia, V.E. and Isidahomen, C.E., 2021. Body measurement parameters as a function of assessing body weight in goats under on-farm research environment. *African Journal of General Agriculture*, 4(3).
- Pragna, P., Chauhan, S.S., Sejian, V., Leury, B.J. and Dunshea, F.R., 2018. Climate change and goat production: Enteric methane emission and its mitigation. *Animals*, 8(12), p.235.
- Saeed, R., Kamran, M.A., Qasim, M., Naheed, S. and Mahmood, I., 2022. Determinants of Livestock Herd Size in Mixed Cropping Zone of Punjab-Pakistan. *Journal of Economic Impact*, 4(1), pp.150–157.
- Shahudin, M.S., Ghani, A.A.A., Zamri-Saad, M., Zuki, A.B., Abdulla, F.F.J., Wahid, H. and Hassim, H.A., 2018. The Necessity of a Herd Health Management Programme for Dairy Goat Farms in Malaysia. *Pertanika Journal of tropical agricultural science*, 41(1).
- Taruvunga, A., Kambanje, A., Mushunje, A. and Mukarumbwa, P., 2022. Determinants of livestock species ownership at household level: Evidence from rural OR Tambo District Municipality, South Africa. *Pastoralism*, 12(1), pp.1–11.
- Tesema, Z., Alemayehu, K., Getachew, T., Kebede, D., Deribe, B., Taye, M., Tilahun, M., Lakew, M., Kefale, A., Belayneh, N. and Zegeye, A., 2020. Estimation of genetic parameters for growth traits and Kleiber ratios in Boer x Central Highland goat. *Tropical Animal Health and Production*, 52, pp.3195–3205.
- Tranmer, M., Murphy, J., Elliot, M., and Pampaka, M., 2020. Multiple Linear Regression (2nd Edition); Cathie Marsh Institute Working Paper 2020-01. <https://hummedia.manchester.ac.uk/institutes/cmist/archive-publications/working-papers/2020/multiple-linear-regression.pdf>.
- Tsvuura, S., Mudhara, M., and Chimonyo, M. (2021). The Effect of Gender on the Commercialisation of Goat Production in the Semi-arid Area of Msinga, South Africa. *Journal of Asian and African Studies*, 56(7), 1559–1576. <https://doi.org/10.1177/0021909620972427>.
- van Herten, J., and Meijboom, F. L. B. (2019). Veterinary responsibilities within the one health framework. *Food ethics*, 3, pp.109–123.
- Venkatachalapathy, R.T., and Saifudeen, S.M., 2020. Socio-Economic Status and Rearing Practices of Tribal Goat Farmers in Attappadi Hills of Kerala, India. *Int. J. Curr. Microbiol. App. Sci*, 9(7), pp.1341–1347.
- Visser, C. and van Marle-koster, E., 2016. Challenges to the development of a rural goat industry in South Africa. *Sustainable Goat Breeding and Goat Farming in Central and Eastern European Countries*, p.189.
- Wodajo, H.D., Gameda, B.A., Kinati, W., Mulem, A.A., van Eerdewijk, A. and Wieland, B., 2020. Contribution of small ruminants to food security for Ethiopian smallholder farmers. *Small Ruminant Research*, 184, p.106064.